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Lab. Project 5046-3, Pt. 47
Final Report
NS 081-001

AW-7

MATERIAL LABORATORY
NEW YORK NAVAL SHIPYARD
BROOKLYN 1, N. Y.

TECHNICAL REPORT

3ND-NYNS-900-P-1B

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CRITICAL THERMAL ENERGIES
of
FLIGHT CLOTHING ASSEMBLIES

Submitted by
THE BUREAU OF AERONAUTICS
Dept. of the Navy

L. Banet
J. Bracciaventi

Lab. Project 5046-3, Part 47
Final Report
NS 081-001
Technical Objective AW-7
AFSWP-392

27 October 1953

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MATERIAL LABORATORY
New York Naval Shipyard
Brooklyn 1, New York

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Final Report

ABSTRACT

For the purpose of evaluating the resistance of flight clothing assemblies to the thermal radiation of atomic explosions, the critical thermal energies of seven assemblies submitted by the Bureau of Aeronautics, Department of the Navy, were determined by exposing the assemblies to the Material Laboratory carbon-arc source of thermal radiation and examining the consequent damage.

The carbon-arc source furnishes a maximum irradiance of 85 $cal/cm^2/sec$ in the central area of the specimens if no absorbing screens were employed. However, for a better approximation of the laboratory exposure time to that obtained in the field, absorbing screens were employed to furnish exposures of 0.3 to 0.6 seconds. Methods of exposure and evaluation of effective damage are indicated. The nylon fabric submitted was consumed at 3.5 cal/cm^2, whereas the cotton twill was destroyed at 12 cal/cm^2. The thermal resistance of the assemblies with a nylon face and wool backing was substantially the same; their first layers were destroyed at 10 and 11 cal/cm^2, their second at 43 and 44 cal/cm^2 respectively. The goatskin leather submitted charred and shrank at about 3 cal/cm^2 and sustained flames after exposures of 15 cal/cm^2 or more. The Vapotex coated cotton twill of Mk-4 exposure suits is more resistant over Mk-4 liner than over wool flannel (55-S-40, Aer).

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Ref: (a) COMNYKNAVSHIPYD conf ltr S99/L5, Ser 960-92 of 14 Mar 1950
(b) BUSHIPS restr spdltr S99(0)(348), Ser 348-75 of 6 Apr 1950
(c) BUAER ltr Aer-Ae-541, J2-7 of 2 Apr 1953

Encl: (1) Critical Thermal Energies of Flight Clothing Assemblies
(2) Spectral Reflectance and Transmittance of Flight Clothing Assemblies

AUTHORITY

1. This investigation is part of the program proposed by reference (a) and formally approved by reference (b). The investigation of the flight clothing assemblies was requested under reference (c). The general Thermal Radiation program is under the supervision of the Armed Forces Special Weapons Project.

INTRODUCTION

2. As part of its general program on the effects of the thermal radiation of atomic explosions on materials, the Material Laboratory is evaluating the characteristics, under exposure to thermal radiation, of various materials of particular interest to the several agencies of the Department of Defense. As data become available, their findings are reported and published.

3. Under reference (c), the Bureau of Aeronautics requested measurements of the critical energies and reflectances of seven flight clothing assemblies. The results of this study are indicated below.

EQUIPMENT AND METHODS EMPLOYED

4. The critical thermal energies of the clothing assemblies were determined, employing the Material Laboratory carbon-arc source of thermal radiation. The source consists of an 11 mm carbon arc mounted at the focus of a parabolic reflector which collimates the emitted energy; a second mirror which is mounted coaxially at a distance of 12 feet from the collimator,

condenses the radiation to the mirror's focus Gradations of thermal damage are obtained by varying the effective exposure time through accelerating a 1 x 8-inch specimen transversely through the focus and using attenuating screens. Without the screens, the rate of application of energy is 85 $cal/cm^2 sec$ over a central area 2 mm wide. The exposure of the cloth assemblies was made by fastening the cloths to glass melamine blocks provided with cut-outs in the central area to furnish an air background. Exposure times between 0.3 and 0.6 seconds were employed for radiant exposures up to 53 cal/cm^2 for those assemblies which were not destroyed at these exposures. Exposures for 0.6 to 1.2 seconds were also used, whenever a sufficient supply of material was available.

5. The spectral reflectances and transmittances of the cloths, which were requested under reference (c), were determined, using the General Electric Recording Spectrophotometer.

RESULTS

6. The critical thermal energies of the cloth fabrics, submitted by the Bureau of Aeronautics, were defined as those which produce certain characteristic , reproducible effects on the materials, such as destruction, charring or melting. The critical energies are shown on Enclosure (1).

7. It may be noted that the laboratory exposures are made under highly controlled conditions and, as a rule, give results which can be reproduced very well. However, for several reasons the data of Enclosure (1) should be used with caution. The effects to be observed on material surfaces remain unchanged over a considerable range of exposures. Since the surface effects are not sufficiently gradated for refined evaluation, only the initial stages have been recorded. The effects are influenced by such factors as mounting, geometry of material and of exposure, weathering and the moisture

content at the time of exposure Differences in density, absorptivity, chemical composition, weave or surface structure are responsible for the variations in effects which may be observed from area to area on the same material. Liquids and gases form during exposure to thermal radiation, even in a period of less than one second, thereby affecting the amount of thermal radiation incident on and absorbed by the surface. In addition to the specific critical energies listed in Enclosure (1), it was observed that of the two assemblies employing the Vapotex coated cotton twill (Mk-4 exposure suit, #5 and #6) the second assembly, employing a padded liner, was more resistant although there was evidence of charring of the padding fibers slightly above the critical energy of 16 cal/cm^2, at which the outer layer was destroyed The first assembly using wool flannel as underlayer, was not completely destroyed at 53 cal/cm^2, but the flannel was so weakened and thinned that it is believed to be close to complete destruction. Due to the shortage of material, the exact critical energy corresponding to destruction of this material could not be determined.

8. The spectral reflectance and transmittance data of the outer cloths are given in Enclosure (2).

CONCLUSIONS

9. The following conclusions may be drawn from the results of this investigation

a. Of the two assemblies which consisted of single layers, the cotton twill (Mil-C-5039) was considerably more resistant than the nylon oxford (Mil-C-508a), the cotton was consumed at 12 cal/cm^2 and the nylon at 3.5 cal/cm^2.

b. There were only minor differences in the critical energies of the two clothing assemblies utilizing a nylon face and wool backing. Their first layers were destroyed at 9 to 10 cal/cm^2 and their second at 43 to 44 cal/cm^2

c. The goatskin leather chars and shrinks at about 3 cal/cm^2. Although the material twists out of focus and is difficult to evaluate at higher exposures, sustained flaming was noted after exposures of 15 cal/cm^2.

d Of the two assemblies employing Vapotex coated cotton twill(Mk-4 exposure suit) cloths the second assembly, including a padded liner is more resistant, since its outer layer is destroyed at 16 cal/cm^2 while the corresponding layer of the first assembly suffers destruction at 12 cal/cm^2

Approved:

H. T. Koonce

H T. KOONCE, CAPTAIN, USN
The Director

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REFLECTANCE AND TRANSMITTANCE
OF FLIGHT CLOTHING
SUBMITTED BY THE BUREAU OF AERONAUTICS

Material No.	#1		#2		#3		#4		#5, #6		#7	
Type of Material	Nylon Oxford (Mil-C-508a)		Cotton Twill (Mil C-5039)		Nylon Face Wool back (Mil 5603) wool to wool		Nylon Face Wool back (Mil-5603) over rayon face		Vapotex coated cotton Twill		Goatskin leather over rayon lin.	
Wavelength (Microns)	R*	T*	R	T	R	T	R	T	R	T	R	T
0.400	0.064	0.030	0.152	0.004	0.032	0	0.032	0	0.109	0	0.045	0
0.420	0.063	0.033	0.148	0.004	0.032	0	0.032	0	0.124	0	0.045	0
0.440	0.058	0.032	0.142	0.005	0.033	0	0.033	0	0.129	0	0.044	0
0.460	0.051	0.028	0.149	0.005	0.037	0	0.037	0	0.139	0	0.045	0
0.480	0.052	0.029	0.167	0.006	0.038	0	0.038	0	0.146	0	0.045	0
0.500	0.055	0.035	0.189	0.010	0.043	0	0.043	0	0.143	0	0.046	0
0.520	0.072	0.055	0.210	0.012	0.050	0	0.050	0	0.148	0	0.048	0
0.540	0.077	0.061	0.226	0.015	0.058	0	0.058	0	0.159	0	0.048	0
0.560	0.096	0.090	0.240	0.017	0.063	0	0.063	0	0.157	0	0.052	0
0.580	0.092	0.079	0.251	0.020	0.063	0	0.063	0	0.149	0	0.058	0
0.600	0.075	0.060	0.269	0.025	0.053	0	0.053	0	0.140	0	0.058	0
0.620	0.072	0.060	0.284	0.030	0.062	0	0.062	0	0.135	0	0.058	0
0.640	0.068	0.051	0.287	0.030	0.053	0	0.053	0	0.131	0	0.058	0
0.660	0.073	0.061	0.284	0.030	0.061	0	0.061	0	0.131	0	0.058	0
0.680	0.121	0.134	0.281	0.030	0.140	0	0.140	0	0.132	0	0.060	0
0.700	0.203	0.236	0.281	0.029	0.281	0.006	0.281	0.002	0.136	0	0.063	0
0.720	0.262	0.298	0.285	0.030	0.442	0.024	0.442	0.006	0.144	0	0.068	0
0.740	0.292	0.330	0.292	0.032	0.558	0.048	0.558	0.010	0.152	0	0.077	0
0.750	0.297	0.340	0.293	0.035	0.602	0.054	0.597	0.010	0.158	0	0.082	0
0.800	0.347	0.392	0.324	0.048	0.680	0.080	0.678	0.040	0.195	0	0.092	0
0.850	0.392	0.440	0.372	0.062	0.702	0.088	0.706	0.055	0.236	0	0.098	0
0.900	0.410	0.455	0.432	0.091	0.716	0.092	0.726	0.063	0.290	0	0.102	0
0.950	0.416	0.462	0.501	0.130	0.722	0.097	0.736	0.070	0.357	0	0.108	0
1.000	0.416	0.470	0.554	0.165	0.726	0.100	0.742	0.078	0.416	0	0.115	0

R* - Reflectance

T* - Transmittance

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1. Textiles - effects of radiation
2. Leather - effects of radiation
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1. Textiles - effects of radiation
2. Leather - effects of radiation
I. Banet, L.
II. Bracciaventi, J.
III. Armed Forces Special Weapons Project
IV. NS 081-001 (AFSWP-392)

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Naval Material Laboratory. New York Naval Shipyard. 5046-3, Part 47

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ABSTRACT

The purpose of this investigation was to determine the contribution of the air-coupled vibrational energy to the overall energy emanating from an enclosed vibrating source. A vibration source suspended in a steel tank was used to simulate a noisy machine mounted within an enclosed chamber.

The vibration exciter or driver was suspended in the tank in three ways: by a solid steel connection, by a resilient mounting, and by a wire.

Recordings were made of the sound intensity outside the tank as the vibration exciter was driven over the frequency range of 60 to 7000 cycles per second (cps). To eliminate the air-coupled energy the tank was evacuated and recordings made.

It was found that: (1) The air-borne vibrations were too low in intensity to affect the decibel (db) readings caused by the structure-borne vibrations when the exciter was mounted solidly to the steel tank. (2) The resilient mounting greatly attenuated the structure-borne vibrations. Using the resilient connection, the air-borne vibrations had little effect on the structure-borne vibrations over a frequency range up to 2000 cps, but from 2000 to 7000 cps, the air-borne vibrations were predominant and raised the decibel level. This shows that air-borne vibrations are significant in the high frequency range. (3) Using the resilient mounting or the wire suspension connections the resilient mounting did not attenuate structure-borne